MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

BER2094 – ENVIRONMENTAL & RESOURCE ECONOMICS

(All Sections/Groups)

15 OCTOBER 2018
9.00 am - 11.00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **SIX (6)** pages including cover page, with Section A and B.
2. Section A consists of **ONE (1)** Case Study. Section B consists of **THREE (3)** Structured Questions.
3. Attempt **ALL** questions.
4. Please write all the answers in the answer booklet provided.
5. The marks distribution for each question is given. Total mark is 100.

SECTION A: CASE STUDY (40%)

Wait—the Ozone Layer Is Still Declining?

The lower stratosphere's ozone continues to decrease, despite the world's success in phasing out ozone-depleting chemicals

In 1985 scientists reported something very unsettling: They had found a hole in the planet's ozone layer over Antarctica. The culprits, they said, were humans emitting chemicals that depleted atmospheric ozone above the South Pole and the rest of the globe. Because the ozone layer protects us and other organisms from harmful solar radiation, the international community united in 1987 to sign the Montreal Protocol, which phased out use of such chemicals.

The protocol, widely considered a huge success since its enactment, significantly dropped the level of ozone-depleting chemicals in the atmosphere, and the "hole" over Antarctica has been shrinking. Yet in a new study published in *Atmospheric Chemistry and Physics*, scientists report that one crucial section of the ozone layer still seems to be declining steadily.

The ozone layer resides in the stratosphere, the region of atmosphere from 10 to 50 kilometers above Earth's surface. This blanket of gas is vital for life on Earth—it absorbs the sun's ultraviolet radiation, which can damage DNA and also promote skin cancer and other harm to humans, wildlife and crops.

In reality, ozone is distributed throughout the lower, middle and upper stratosphere as well as in the troposphere, the atmosphere's bottom layer that extends up from Earth's surface to about 10 kilometers. Thanks to the protocol, from the late 1990s on, ozone in the stratosphere "looked like it wasn't going down anymore, which is a massive success," says William Ball, a researcher in atmospheric physics at ETH Zürich and one of the study authors. But precise measurements of the lower stratosphere have been difficult to make. "One of the key problems that's been left unresolved is that in the lower stratosphere, there's lots of variability that we don't capture in the approach that we typically take to work out what the trends are," Ball says.

Ball and a team of researchers from institutions around the world wanted to more accurately measure trends in the ozone layer. For their study, they synthesized and then analyzed multiple satellite data sets of atmospheric ozone. The data cover the tropics and mid-latitudes, from 1985 through 2016. The team found ozone in the upper stratosphere has indeed rebounded since 1998. "It's clear it's going back up," Ball says. "This is exactly where we'd expect to see the Montreal Protocol working its best." They also discovered ozone in the troposphere—which comes in large part from air pollution—rose from 2004 through 2016.

Continued ...

They observed, however, no significant upward or downward trends for the middle stratosphere, or for the total ozone column—the sum of the troposphere and stratosphere—since 1998. Starting in 1985 "you can see [the total ozone column] is going down," Ball says. "After 1998 we see ozone stop depleting, initially see a slight rise and then it seems to stall." But the rise was statistically nonsignificant, Ball notes. "What this says is, great, since 1998 ozone hasn't been depleting any further." But it also does not appear to be rebounding.

What is the culprit? Ball's team found the ozone in the lower stratosphere has slowly, continuously dropped since 1998. "We see a small but persistent and continuous decline—not as fast as before 1998 but a continued [trend] down," he says. "This is surprising, because we would have expected to also see this [region's ozone] stop decreasing." The finding is important because the lower stratosphere contains the largest fraction of the ozone layer.

Overall, Ball says, global ozone has declined 5 percent between 1970 and 1998—prior to the protocol's effect. Since then "our analysis suggests that the [ozone in the] stratosphere has declined...another 0.5 percent, most of which has occurred in the lower stratosphere," he says. "It doesn't sound like much, and it's slower, but it's contradictory to the trajectory expected in models."

The research team does not yet know the cause of this persistent decline in lower stratospheric ozone. In their paper they venture a handful of possible explanations, several of which are driven by climate change. Another potential reason might be that rising emissions of short-lived chemicals are reaching the lower stratosphere and destroying ozone. But these are just hypotheses scientists still need to explore. "It's quite clear that the Montreal Protocol has worked," Ball says. "But it looks as if something else has come on the stage, and we don't really know what it is."

Outside experts are both impressed by the new study and troubled by its findings. "It's really concerning, because we do not know what's going on," says Michaela Hegglin, an associate professor in atmospheric chemistry at the University of Reading in England. "We're all looking around for signs of recovery, and now this paper comes out and says that the lower stratosphere is declining."

People should not panic over this new finding, Ball cautions. "At the moment, the [total ozone] column is not getting worse," he says. But, he adds, "We should be worried. We need to urgently sort this out, because we don't want the ozone layer to get worse."

Continued ...

A. R. Ravishankara, a professor in the departments of Chemistry and Atmospheric Science at Colorado State University, says this finding also teaches the world an important lesson. "When you make environmental policies, you study the problem, diagnose, take action—and then most people assume that you're done. But that's not the case," he says. "[You have to] continue to measure and monitor, to make sure that what's happening is what you predicted. We cannot take our eyes off the ball."

Hegglin agrees: "The world should realize that the ozone layer story has not ended."

Source: Sneed, Annie. "Wait--the Ozone Layer Is Still Declining?" Scientific American, 6 Feb. 2018, www.scientificamerican.com/article/wait-the-ozone-layer-is-still-declining1/.

Based on the above article, answer the following questions:

a) Based on your understanding, define ozone depletion and its primary causes. (7 marks)

b) Refer to the article, determine the objective of Montreal Protocol 1987. (3 marks)

c) *"Yet in a new study published in Atmospheric Chemistry and Physics, scientists report that one crucial section of the ozone layer still seems to be declining steadily."*

Refer to the above statement, examine the potential reasons for the above problem. (6 marks)

d) *"In reality, ozone is distributed throughout the lower, middle and upper stratosphere as well as in the troposphere, the atmosphere's bottom layer that extends up from Earth's surface to about 10 kilometers."*
Based on the article, which level of stratosphere showed no significant upward or downward trends? (3 marks)

e) Based on A. R. Ravishankara, a professor in the departments of Chemistry and Atmospheric Science at Colorado State University, describe the lesson that we can learn from the above finding? (3 marks)

f) As an environmental economist, demonstrate a modeling on excise tax to phase out such chemicals. Explain. (9 marks)

g) Besides excise tax, suggest another market approach that might be suitable to phase out such chemicals. Explain in detail with the necessary aid of an example or a diagram. (9 marks)

Continued ...

SECTION B: STRUCTURED QUESTIONS (60%)

QUESTION 1 (20 MARKS)

a) The Environmental Kuznets Curve (EKC) is a hypothesized relationship between environmental quality and economic development. Illustrate and explain with a suitable diagram. (10 marks)

b) Illustrate Pollution Prevention (P2). Examine any **TWO (2)** Pollution Prevention (P2) techniques. (10 marks)

QUESTION 2 (20 MARKS)

a) To feed another two billion people in 2050, food production will need to increase by 50 percent globally. Discuss any **TWO (2)** causes of global food insecurity. (10 marks)

b) Measuring the Benefits of Water Pollution Abatement shows the aspects of benefit calculations in the context of water pollution control. Justify any **TWO (2)** major difficulties in assessing the benefits. (10 marks)

QUESTION 3 (20 MARKS)

a) The following equations showed the Marginal Private Cost (MPC), Marginal Social Cost (MSC) and Marginal Social Benefit (MSB) for the dioxins (a type of hazardous waste) waste service:

$$MPC = 1.1 + 0.9Q$$
$$MSC = 1.5 + 1.25Q$$
$$MSB = 30 - 2.5Q$$

Note: Q is thousands of tons per week and the dollar values are per ton. Assume that there are no consumption externalities in this market.

i) Identify the negative externality equation in this market. (2 marks)

ii) Calculate the competitive equilibrium price and quantity. (2 marks)

iii) Determine the socially optimal price and quantity. Measure the amount of the resource misallocation related with the competitive market solution. (4 marks)

iv) Compute the waste-end charge ($ per unit) that would fix the efficiency to this market. (2 marks)

Continued ...

b) The following equations are the Total Social Benefit (TSB), Marginal Social Benefit (MSB), Total Social Cost (TSC) and Marginal Social Cost (MSC) for the cost and benefit analysis on Environmental Quality Act 1974 amendment 2017:

$$TSB = 75A - 0.4A^2$$
$$MSB = 75 - 0.8A$$
$$TSC = 25A + 0.85A^2$$
$$MSC = 25 + 1.7A$$

Note: A is the percent of pollution abatement; costs and benefits are quantified in millions of dollars.

i) Estimate the TSB and TSC allied with an abatement standard (A) of 30. (2 marks)

ii) Based on the answer from (i), verify and justify whether this abatement standard is efficient or not. (3 marks)

iii) Find the efficient abatement standard for the above problem. (5 marks)

End of Page